RESEARCH AND SCIENCE IN ALBERTA 1983-84

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SYMBOLS

..	figures not available
--	nil or amount too small to be expressed
e	estimates
r	revised figures

NOTES

1. Totals may not be the sums of component parts due to rounding.

2. Figures cited for 1982-83 may reflect revision of previously published estimates.

3. The abbreviated form "social science" may be used to refer to both the social sciences and humanities.

ABSTRACT

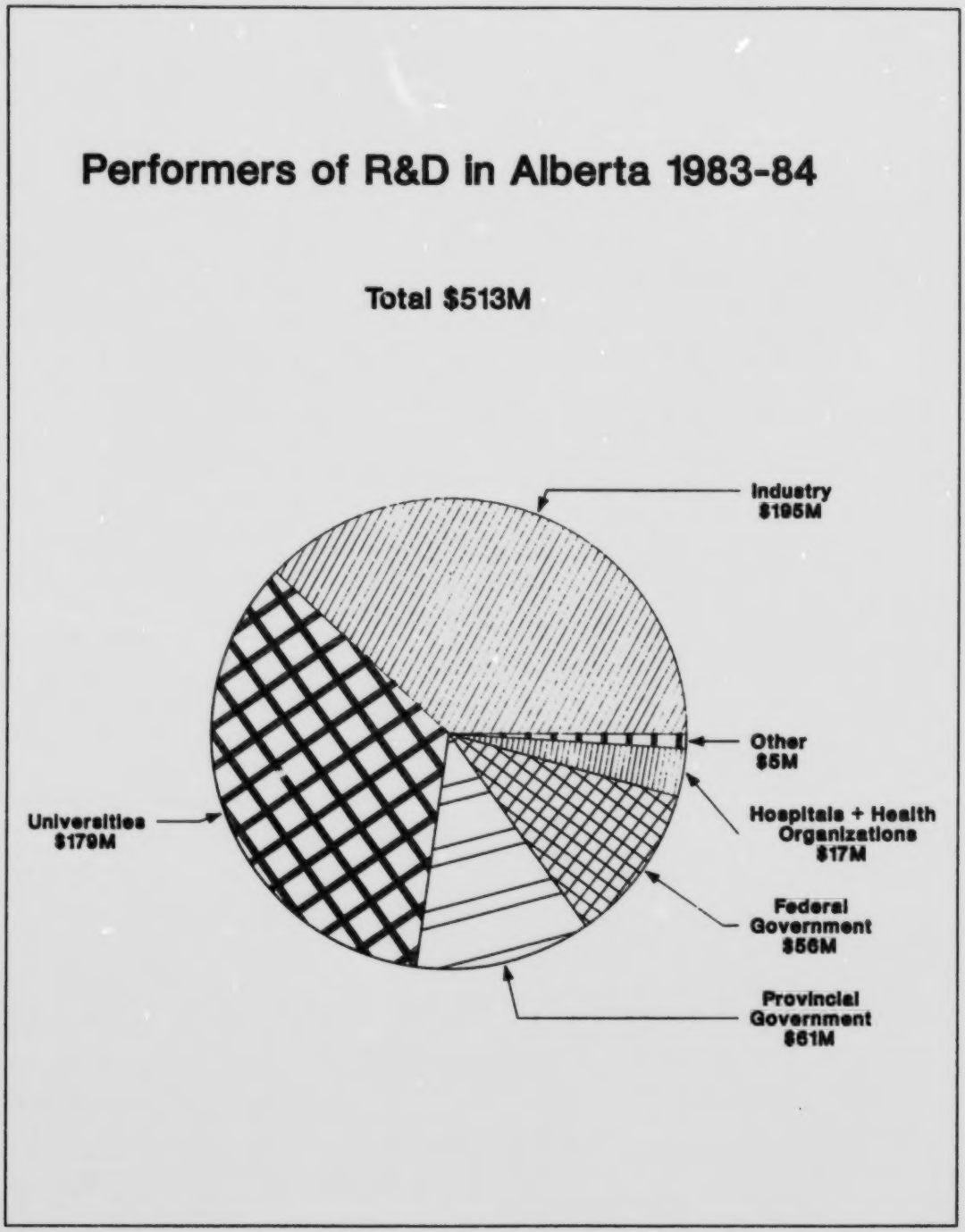
1. PREFACE

This report describes the characteristics and magnitude of research and science expenditures in Alberta during the fiscal year 1983-84. An introductory section provides background information and outlines the organization of the report. Section I outlines research and development expenditures in Alberta by all funding and performing sectors, and examines areas of application and personnel components. Section II focuses on the Alberta Government's expenditures for both research and development and related scientific activities and draws comparisons with expenditures of other provincial governments. Section III provides an overview of specific research programs and facilities in the Province.

The data contained in this report were based primarily on an annual Statistics Canada survey of scientific activities of the Government of Alberta, various other statistical surveys conducted by Statistics Canada, and estimates produced by the Planning Secretariat of Alberta Advanced Education.

As this report is exploratory in nature and represents one of the few attempts at documenting all expenditures on research and science in Alberta, it should be used with caution. Due to limitations in the available data, these figures should be considered only as reasonable approximations.

FIGURE 1


Performers of R&D in Alberta 1983-84
Total $513M
Industry
$195M
Other
$5M
Hospitals + Health
Organizations
$17M
Federal
Government
$56M
Provincial
Government
$61M
Universities
$179M

2. SUMMARY OF MAJOR FINDINGS AND OBSERVATIONS

1. **Total Research And Development Expenditures By All Sectors In The Province Were Approximately $513 Million During The Fiscal Year 1983-84 (Table 1).**

   This represents a decrease of 8 percent over the $554 million spent in 1982-83, but continues to account for approximately 10 percent of all research and development expenditures in Canada. On a per capita basis, research and development expenditures in Alberta ($217 per capita) were at the same levels as those for Canada as a whole ($216 per capita). As a proportion of Gross Domestic Product, Alberta's expenditure on research and development was 45 percent lower than that of Canada.

2. **Industry Performed 38 Percent ($195 Million) Of The Total Dollar Value Of Research And Development Activities In Alberta (Table 4).**

   Industry was the primary performer of research and development in Alberta, particularly in the natural sciences. Alberta Industry accounted for 8 percent of all industrial research in Canada. Activities were directed primarily toward oil and gas production and petroleum-based chemical research.

3. **Alberta Universities Performed 35 Percent ($179 Million) Of The Dollar Value Of Research And Development Activities In Alberta, Only Slightly Less Than The Industry Sector (Table 4).**

   Approximately 47 percent of the research performed by Alberta Universities was sponsored by external organizations. Seventy percent of the dollar value of research and development activities performed by Alberta Universities was in the natural sciences; the remaining 30 percent was in the social sciences. Alberta Universities remain the primary performers of research and development in the social sciences and humanities.

4. **The Federal Government Performed 11 Percent ($56 Million) Of The Total Dollar Value Of Research And Development Activities In Alberta (Table 4).**

   The Federal Government, through its research establishments located in Alberta, performed 55 percent of the research and development which it funded in the Province. This amounted to 5 percent of all research and development performed by the Federal Government in Canada.

5. **The Alberta Government, Including The Alberta Research Council, Performed 12 Percent ($61 Million) Of The Total Dollar Value Of Research And Development Activities In Alberta (Table 4).**

   Although the Provincial Government is still considered primarily a funder, rather than a performer, of research and development, intramural expenditures by Alberta Government Departments increased 19 percent in 1983-84 over 1982-83. As a proportion of its total expenditure on research and development, the Government of Alberta performed 47 percent of the activities it funded in 1983-84.

6. **The Alberta Government Funded 25 Percent ($129 Million) Of All Research And Development In Alberta (Table 2).**

   With an increase of 10 percent over 1982-83 expenditures, the Alberta Government expended more for research and development than any other provincial government surveyed. On a per capita basis, the Alberta Government continued to fund research and development at over three times the level of any other provincial government.

7. **The Federal Government Funded 20 Percent ($103 Million) Of Research And Development In Alberta (Table 2).**

   This represents an increase of $11 million over the $92 million spent in 1982-83, and accounts for approximately 5 percent of the Federal Government's total research and development expenditures in Canada. The Federal Government was the major contributor to sponsored research at Alberta Universities.

8. **Industry Funded 29 Percent ($150 Million) Of Research And Development In Alberta (Table 2).**

   Industry decreased its expenditures on research and development in Alberta by $70 million over 1982-83, due primarily to decreases in expenditures by the petroleum recovery industries. Alberta Industry's share of support for research and development was below the Canadian average.

9. **Alberta Universities, From Operating Funds, Supported 18 Percent ($94 Million) Of Research And Development In Alberta (Table 2).**

   Universities are estimated to have increased their support of unsponsored research by $7 million over 1982-83. In addition, sponsored research in the university sector has grown by 13 percent from $75 million in 1982-83 to $85 million in 1983-84.

10. **Natural Sciences Research And Development Expenditures In Alberta Were Approximately $458 Million. Social Sciences and Humanities Research And Development Expenditures Were Approximately $55 Million (Table 1).**

    Natural sciences research and development activity accounted for 89 percent of all research and development expenditures in Alberta, with the remaining 11 percent expended in social sciences research.

11. **Approximately 32 Percent ($162 Million) Of Research And Development Expenditures In Alberta Were Directed Toward The Area Of Energy and Fuels (Table 5).**

    This is a considerably lower level of energy research than in past years (41 percent of research and development in 1982-83), and is accounted for primarily by decreased spending in the industrial sector. Proportionate increases were seen in health and social development, and in industrial and economic development.

12. Excluding University Personnel, 1 516 Scientific And Professional Personnel As Well As 1 878 Technical And Other Support Personnel Were Employed In Research And Development Activity In Alberta (Table 6).

Of scientific and professional personnel employed in Alberta, (excluding those employed by Universities), 58 percent were employed in Industry, 20 percent in Federal establishments, 12 percent in Alberta Government Departments and 10 percent in the Alberta Research Council.

13. Total Expenditures On Scientific Activity By The Alberta Government Were $189 Million In 1983-84 (Table 8).

Of total scientific activity expenditures, approximately $129 million was directed toward research and development and $61 million was expended for related scientific activities. Expenditures for scientific activity increased 9 percent over the preceding fiscal year.

BACKGROUND AND TECHNICAL NOTES

1. INTRODUCTION

Research and science continue to play an increasingly important role in the economies of both Canada and the Province of Alberta. There is every indication that the future economic strength of the Province and the nation will be strongly influenced by the support of research and development by industry, universities, and government.

This report describes the characteristics and magnitude of scientific expenditures in Alberta. It outlines the research and development expenditures in Alberta by all who fund or support such activities. Particular attention is paid to the support provided by the Government of Alberta.

The data upon which this report is based are difficult to compile in a consistent fashion. While the methods used in the preparation of this material have been improving, caution should be exercised in drawing comparisons with other similar data sources.

1.1 Background

Since 1973-74, an annual survey of the scientific activities of the Government of Alberta has been carried out by Statistics Canada (currently in cooperation with the Department of Advanced Education and the Alberta Bureau of Statistics). This survey provides the only continuing historical data base on the scientific activities of the Government of Alberta, and represents one of the few reliable data bases available to review the overall scientific activities of the Alberta Government. (The 1983-84 survey results are found in Appendix A.)

In order to provide a comprehensive data base to aid in formulating policy decisions, the results of this survey have been placed in a broader comparative context. Research and Science in Alberta, 1983-84 offers a broad examination of the existing data relating to the scientific expenditures of the Federal Government, Alberta Industry, Alberta Universities, and other Provincial Governments as well as the Government of Alberta. By comparing the

contributions of each sector of the Alberta and Canadian economies, a clearer perspective of the total effort of research and science may emerge. There has been a growing recognition among all governments of the important place of research and development in an expanding economy. As a result, similar provincial surveys of scientific activities are currently conducted in four provinces: British Columbia, Alberta, Saskatchewan and Ontario. New Brunswick instituted a partial survey in 1983-84, and the Manitoba Government will conduct a full survey in 1984-85.

1.2 Data Sources And Cautionary Notes

The data contained in this report are based on Statistics Canada surveys of scientific activities and on estimates produced by the Planning Secretariat of the Alberta Department of Advanced Education. Due to limitations in source information, these estimates should be considered only as reasonable approximations.

Information on scientific expenditures in Alberta has been collected, where possible, as reported by the funder. This approach is feasible when dealing with federal or provincial governments, as annual surveys of their science expenditures reflect payments to all performing sectors. For various reasons a performer may not identify the same funding as the agency providing the funding. Therefore, discrepancies arise when the performer's report is the only source of data for a given sector.

This is the case when accounting for expenditures by industry. The Statistics Canada publication, Industrial Research and Development Statistics, offers data from an annual survey of Canadian industry engaged in scientific activities. Since the publication summarizes expenditures by report of the performer, irreconcilable differences exist between these figures and those reported in similar data sources by survey of the funder. Therefore, caution should be exercised when comparing figures from various data sources.

Data on university expenditures are estimates produced by the Planning Secretariat of Alberta Advanced Education. These estimates are derived from annual financial statements of Alberta universities and from studies which

indicate that a fixed percentage of the operating expenditures of universities is attributable to research and development activity (Report of the Study on the Costs of University Research, Canadian Association of University Business Officers, 1982). Estimates of university expenditures on research and development present the greatest potential for error; however, no figures of a more precise nature currently exist. (A brief discussion of the methodology used in deriving these data is contained in Appendix C.)

All figures in this report, unless otherwise noted, refer to expenditures on research and development only. In order to estimate the extent of research and development activity in Alberta, foreign payments to Industry for research performed in Alberta are included, but payments for research performed outside of the country are not. Capital expenditures on research and development are included for all sectors, with the exception of the University sector (See Appendix C). All figures are in current dollars.

1.3 Definitions

Scientific activities are defined as those scientific and technological activities which involve the generation, dissemination and initial application of new scientific and technological knowledge. These activities include both research and development activities and related scientific activities. Scientific activities are classified as belonging either to the natural sciences and engineering, or to the social sciences and humanities. (Detailed definitions of the terms used in this report are found in Appendix B.)

Research and development activities are defined as creative work undertaken on a systematic basis towards the acquisition and application of new scientific and technological knowledge.

Related scientific activities are defined as those activities which are supportive of research and development, but which do not include the acquisition of new knowledge. By convention, they include such activities as education support, statistical surveys, information services, special services and studies (systematic investigations carried out to provide information needed for planning or policy formulation), and the provision of museum services.

1.4 Outline

This report consists of three major sections. The first statistical section 'Research and Development in Alberta', outlines expenditures for research and development in Alberta for the fiscal year 1983-84, identifies the major funders and performers of these activities, and describes research and development by area of application.

The second statistical section, 'Scientific Activities of the Government of Alberta', provides a more detailed view of the Alberta Government's expenditures. It includes information on both research and development activities and related scientific activities. Comparisons have been made with other provincial governments for which data are available.

The third section, 'Overview of Research and Science in Alberta', is a narrative, and new to the report this year. Although a summary of science expenditure data is integral to policy formulation, a more comprehensive information base should include some description of the specific nature of research activity in the Province. The final section of the report, therefore, provides an overview of the activities of various research funding and performing sectors in Alberta.

SECTION I
RESEARCH AND DEVELOPMENT IN ALBERTA: STATISTICS 1983-84

1. INTRODUCTION

This section describes the characteristics and magnitude of research and development expenditures in Alberta during the fiscal year 1983-84. It outlines the expenditures of the Alberta Government, the Federal Government, Universities, Industry, and 'Others', and identifies the major performers of research and development. Areas of application have been identified, as have the personnel components of each sector.

2. RESEARCH AND DEVELOPMENT EXPENDITURES

In 1983-84, approximately $513 million was spent on research and development activities in Alberta. This represented a decrease of 8 percent over 1982-83, and accounted for approximately 10 percent of all research and development expenditures in Canada (Table 1).

As an indication of how expenditures on research and development relate to the overall performance of the economy, it is possible to express research and development as a percentage of Gross Domestic Product (GDP). Research and development accounted for .92 percent of Alberta's GDP in 1983-84, down from 1.04 in 1982-83. The comparable research and development expenditure in Canada was 1.33 percent of the nation's GDP (1.35 percent for 1982-83).[1]

However, it should be noted that differences in industrial structure between regions tend to distort this type of calculation. The greatest opportunity for research and development investment exists in the manufacturing sector. Alberta's largely resource-based economy puts the Province at an apparent disadvantage when GDP is employed as a measure of research and development intensity.

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[1] Alberta Advanced Education, Planning Secretariat, estimates, July, 1985; Alberta Bureau of Statistics, Alberta Economic Accounts 1983; Statistics Canada, Scientific Activities of the Government of Alberta 1983-84 Survey Results.

TABLE 1

RESEARCH AND DEVELOPMENT EXPENDITURES
IN ALBERTA 1982-83 AND 1983-84,
AND CANADA 1983-84

Field of Science	$ Millions (%)					
	Alberta 1982-83(r)		Alberta 1983-84		Canada 1983-84	
Natural Sciences	503	(91)	458	(89)	4 876	(91)
Social Sciences	50	(9)	55	(11)	489	(9)
Total	554	(100)	513	(100)	5 365	(100)

Sources: Alberta Advanced Education, Research and Science in Alberta 1982-83; Alberta Advanced Education, Planning Secretariat, estimates, July, 1985; Alberta Research Council, Annual Report 1984; Statistics Canada, Federal Scientific Establishments 1983-84; Statistics Canada, Scientific Activities of the Government of Alberta 1983-84 Survey Results; Statistics Canada, Science, Technology and Capital Stock Division, estimates, May, 1985; University of Alberta, Report of the Governors 1983-84; University of Calgary, Annual Report 1983-84; University of Lethbridge, Financial Statements 1983-84.

Recognizing the limitations of the measure, the Organization for Economic Cooperation and Development[1] has recommended calculating these statistics on a per capita basis. When this procedure is applied to Alberta statistics, the Province fares more favourably: expenditures are either comparable with those elsewhere in Canada, or higher. In 1983-84 roughly $217 per capita were spent on research and development activities in Alberta, compared with $216 per capita in Canada. In 1982-83 about $239 per capita were spent on research and development in Alberta as compared with $204 per capita across Canada.[2]

2.1 Research and Development Expenditures in the Natural Sciences

In Alberta, research and development expenditures in the natural sciences were approximately $458 million in 1983-84, down by 10 percent over 1982-83. These expenditures represented roughly 89 percent of all research and development expenditures in Alberta, and 9 percent of all natural science research and development expenditures in Canada. Approximately $194 per capita were expended on natural science research and development activities in Alberta, while approximately $196 per capita were expended on natural science research and development activities in Canada.

2.2 Research and Development Expenditures in the Social Sciences and Humanities

In Alberta, research and development expenditures in the social sciences were approximately $55 million in 1983-84, an increase of $5 million or 10 percent over 1982-83. This represented roughly 11 percent of all research and development expenditures in Alberta, and 11 percent of all social science research and development expenditures in Canada. Approximately $23 per capita were expended on social science research and development activities in Alberta, while approximately $20 per capita were spent on social science research and development in Canada (Table 1).

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1 OECD Science and Technology Indicators: Resources Devoted to Research and Development, Paris, 1984, p.26.

2 Alberta Advanced Education, Planning Secretariat, estimates, July, 1985; Alberta Bureau of Statistics, Alberta Economic Accounts 1983; Statistics Canada, Scientific Activities of the Government of Alberta 1983-84 Survey Results.

3. SOURCES OF FUNDS

Alberta's research and development activities were funded by five sectors: the Provincial Government, the Federal Government, Industry, Universities, and 'Others' (primarily private non-profit organizations and foreign sources). In 1983-84, Industry provided 29 percent of all research funds, the Provincial Government 25 percent, the Federal Government 20 percent, Universities 18 percent, and 'Others' 7 percent. (The support by 'Others' includes foreign funding of industrial research and development.) In Canada, Industry funded approximately 39 percent of all research and development expenditures, the Federal Government 36 percent, Universities 11 percent, Provincial Governments 7 percent, and 'Others' 7 percent (Table 2).

3.1 Provincial Government

In 1983-84 the Provincial Government was the second largest funder of research and development activities. The Alberta Government was the source of $129 million in research and development funds, accounting for 25 percent of total research and development expenditures in Alberta (Table 2).

The Alberta Heritage Foundation for Medical Research, funded from the proceeds of a $300 million endowment by the Provincial Government, is considered for the purposes of this analysis, to be a private non-profit research organization. Thus its support of university research ($23 million[1] in 1983-84) is included under 'Others'.

In 1983-84 the Government of Alberta expended more for research and development than did any other provincial government surveyed. In 1983-84, the Ontario Government's expenditures on research and development were roughly $114 million. The British Columbia Government's expenditures on research and development were $23 million, while Saskatchewan's expenditures were

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[1] This figure is as reported by offices of research services at Alberta universities.

TABLE 2

RESEARCH AND DEVELOPMENT EXPENDITURES
BY SOURCE OF FUNDS IN ALBERTA 1982-83 AND 1983-84,
AND CANADA 1983-84

Source of Funds	$ Millions (%)					
	Alberta 1982-83(r)		Alberta 1983-84		Canada 1983-84	
Provincial Government(s)	117	(21)	129	(25)	398	(7)
Federal Government	92	(17)	103	(20)	1 955	(36)
Industry	220	(40)	150	(29)	2 069	(39)
Universities	87	(16)	94	(18)	567	(11)
Others	37	(7)	38	(7)	375	(7)
Total	554	(100)	513	(100)	5 365	(100)

Sources: See Table 1.

TABLE 3

RESEARCH AND DEVELOPMENT EXPENDITURES OF
SELECTED PROVINCIAL GOVERNMENTS AND
THE FEDERAL GOVERNMENT 1983-84

Field of Science	Governments $ Millions (%)									
	Alberta		Ontario		Saskatchewan		British Columbia		Federal (in Canada)	
Natural Sciences	126	(98)	91	(80)	16	(95)	23	(98)	1 852	(95)
Social Sciences	2	(2)	23	(20)	1	(5)	1	(2)	103	(5)
Total	129	(100)	114	(100)	17	(100)	23	(100)	1 955	(100)

Sources: Statistics Canada, annual surveys of scientific activities of the respective provinces, 1983-84; Statistics Canada, Science, Technology and Capital Stock Division, estimates, May, 1985.

$17 million. On a per capita basis, the Alberta Government spent over three times more on research and development than any other provincial government for which data were available (Table 3).

3.2 Federal Government

In 1983-84, the Federal Government funded approximately $103 million of research and development in Alberta, up from $92 million in 1982-83.[1] This sector was the source of approximately 20 percent of all research and development expenditures in Alberta, compared with 36 percent of all research and development in Canada. Support of research in Alberta accounted for 5 percent of the Federal Government's total research and development expenditures in Canada (Table 2).

In 1983-84, the Federal Government's extramural expenditures on research and development in Alberta were approximately $46 million, excluding money transferred to the Province through the Alberta/Canada Energy Resources Research Fund. (Funds which were transferred to the Province under this agreement are reported as provincial research and development expenditures.)

3.3 Industry

Although in 1983-84 Industry remained the primary funder of research and development in Alberta, its expenditures decreased 46 percent over 1982-83. Alberta Industry spent approximately $150 million on research and development in 1983-84, down from $220 million in 1982-83. Accordingly, the proportion of research in Alberta funded by the private sector decreased from 40 percent in 1982-83 to 29 percent in 1983-84. Alberta Industry's expenditures on research and development as a proportion of all Industry funded research and development in Canada decreased to 7 percent in 1983-84 from 11 percent in 1982-83 (Table 2).

Part of the decrease can be accounted for by a reduction in capital projects. Beginning in 1979-80, Alberta Industry made significant capital expenditures

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[1] Federal tax incentives to the private sector are not considered direct funding for research and development, and are therefore not included in this summary.

on research facilities (including land, buildings and equipment). As acquisition slowed in 1983-84, capital expenditures decreased 89 percent over 1982-83, falling from $85 million to $45 million. (See section 4.1 for further discussion of the recent pattern of expenditures in this sector.)

3.4 Universities

In 1983-84, it is estimated that Alberta Universities, through their operating budgets, funded approximately $94 million of research and development activities in Alberta, up from $87 million in 1982-83. This sector accounted for approximately 18 percent of all research and development expenditures in Alberta, and represented 17 percent of all expenditures by Canadian Universities on research and development in Canada (Table 2). (These estimates do not include research supported by sources external to the universities, as these funds are recorded under the sector which provided the funds. See Appendix C for the methodology used to estimate university support for research and development activities.)

3.5 'Others'

'Other' organizations, primarily private non-profit organizations and foreign sources, funded approximately $38 million of research and development activities in Alberta in 1983-84. This sector accounted for approximately 7 percent of all expenditures on research and development in Alberta and approximately 10 percent of total expenditures by 'Other' funders on research and development in Canada (Table 2).

Foreign funding of industrial research and development ($6 million) decreased to half its 1982-83 level ($12 million). The remaining funds reported as 'Other' (approximately $32 million) were provided primarily by Alberta's private non-profit organizations for research and development performed by the University sector. The Alberta Heritage Foundation for Medical Research accounted for the largest expenditure by a private non-profit organization, providing $23 million[1] to Alberta Universities for research and development activities.

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1 This figure is as reported by offices of research services at Alberta universities.

4. PERFORMERS

The two major performers of research and development in Alberta were the Industry and University sectors. Together these sectors accounted for 73 percent of the dollar value of research and development activities in Alberta. The Federal Government and Provincial Government Departments accounted, respectively, for 11 percent and 5 percent of all research and development performed in Alberta. The Alberta Research Council accounted for an additional 6 percent of expenditures for research and development activities in 1983-84 (Table 4).

4.1 Industry

In 1983-84 Industry remained the primary performer of research and development in Alberta in spite of a 38 percent decrease in intramural expenditures. Industry accounted for $195 million or approximately 38 percent of the total dollar value of research and development activities in Alberta. Nationally, Industry accounted for 47 percent of all expenditures for research and development (Table 4).

The substantial decrease in industrial research and development activity marks a continuation of the decline first observed in 1982-83. Remarkable expansion between 1977-78 and 1981-82 led to an increase of 250 percent in intramural expenditures by Alberta Industry, compared with an increase of 148 percent over the same time period across Canada. But by 1982-83, decreased spending in Alberta petroleum recovery industries contributed to an overall decrease of 4 percent over 1981-82 levels.

The further decrease in 1983-84 industrial expenditures appears to have resulted from continued reductions in research and development spending in the petroleum recovery industries, where expenditures decreased from $203 million in 1982-83 to $127 million in 1983-84. However, research and development expenditures in the service industries continued to show a slight increase (7 percent) over 1982-83 levels.

TABLE 4

RESEARCH AND DEVELOPMENT EXPENDITURES BY PERFORMER IN ALBERTA 1982-83 AND 1983-84, AND CANADA 1983-84

Performer	$ Millions (%)								
	Alberta 1982-83(r)			Alberta 1983-84			Canada 1983-84		
Provincial Government(s)									
Intramural	23	(4)		27	(5)		160	(3)	
Research Council(s)	34	(6)		33	(6)		59	(1)	
Subtotal		56	(10)		61	(12)		219	(4)
Federal Government		50	(9)		56	(11)		1 224	(23)
Industry		271	(49)		195	(38)		2 518	(47)
Universities		162	(29)		179	(35)		1 341	(25)
Others									
Hospitals and Health Organizations	11	(2)		17	(3)		..	..	
Other	3	(1)		5	(1)		..	..	
Subtotal		14	(3)		22	(4)		63	(1)
Total		554	(100)		513	(100)		5 365	(100)

Sources: See Table 1.

Of the $195 million expended intramurally by Industry, funds for 16 percent (approximately $32 million), were received from the Provincial Government and 5 percent (approximately $10 million) was received from the Federal Government, for a total of approximately $40 million. Foreign support for research and development performed by Alberta Industry amounted to $6 million, accounting for 3 percent of Industry's research and development funding.

4.2 Universities

The second major performer of research and development activities in Alberta in 1983-84 was the University sector. It performed approximately 35 percent or $179 million of research and development activities in Alberta, compared with the Canadian average for Universities of 25 percent (Table 4).

Approximately 70 percent was in the natural sciences where, with expenditures of $125 million, Alberta Universities performed approximately 27 percent of the dollar value of natural science research and development activities in the Province. The remaining 30 percent of research and development performed by Alberta Universities was in the social sciences and humanities.

Universities are the major performers of research and development in the social sciences and humanities. The $54 million in social science research performed by Alberta Universities accounted for 97 percent of the total dollar value of social science research in Alberta. This particularly high contribution results partly from the fact that, although other sectors are active in scientific activities in the social sciences, little of their work can be classified as research and development. For example, in 1983-84 Provincial Government Departments performed $18 million of scientific activity in the area of social sciences, but of this only one half million dollars was designated as research and development.

Approximately 47 percent of the dollar value of the research and development performed by the Universities was sponsored or funded by external organizations. The remaining 53 percent was funded through university operating budgets. Approximately 8 percent of the total dollar value of research and development performed by the Universities in the social sciences

was sponsored by external organizations, compared to 64 percent sponsorship in the natural sciences.

The major external sponsor of research activities at Alberta Universities is the Federal Government, accounting for 43 percent of all sponsored research in 1983-84. The Alberta Heritage Foundation for Medical Research accounted for 27 percent; other private non-profit organizations funded 10 percent; the Provincial Government 16 percent; and Industry 3 percent.

4.3 Federal Government

In 1983-84, Federal Government scientific establishments located in Alberta expended $56 million, a 12 percent increase over 1982-83 expenditures. Research conducted by the Federal Government in Alberta accounted for 11 percent of all research and development in the Province. Nationally, Federal Government research and development accounted for 23 percent of research and development expenditures in Canada. Virtually all research performed by the Federal Government in Alberta was in the natural sciences (Table 4).

4.4 Provincial Government

Although the Provincial Government is still considered primarily a funder rather than a performer of research and development, intramural expenditures by the Alberta Government Departments rose from $23 million in 1982-83 to $27 million in 1983-84, a 19 percent increase in research and development activities (Table 4). Together, the Alberta Provincial Departments and the Alberta Research Council performed 12 percent of all research and development activities in Alberta.

Provincial Government Departments performed approximately 21 percent of the total dollar value of research and development activities funded by the Government of Alberta, and the Alberta Research Council performed another 26 percent. Other provincial governments performed proportionately more of the research they funded, and the provincial research organizations proportionately less. The Alberta Government contributed a substantially

greater share of research funds to hospitals and health organizations than did other provincial governments.

During 1983-84, British Columbia performed 53 percent of the value of research and development it funded, with an additional 5 percent performed by the British Columbia Research Council. In Saskatchewan, 22 percent was performed intramurally and 23 percent was performed by the Saskatchewan Research Council. The Ontario Government performed 48 percent of the total dollar value of the research and development activities it funded, and the Ontario Research Foundation performed an additional 4 percent.

Industry was commissioned to perform approximately 25 percent of the total dollar value of the Alberta Government's expenditures on research and development. The proportion of the Ontario Government's expenditures performed by Industry was 10 percent; in British Columbia it was 8 percent; in Saskatchewan, Industry's share was 20 percent.

Universities received approximately 11 percent of the Alberta Government's research and development funds. The comparable figure for Saskatchewan was 33 percent, for Ontario 28 percent, and for British Columbia 23 percent.

'Other' performers, including hospitals and health organizations, received approximately 17 percent of the Alberta Government's expenditures for research and development. The comparable figure for Ontario was 9 percent, for British Columbia 9 percent, and for Saskatchewan 2 percent.

5. APPLICATION

Data collected on Provincial Government expenditures by area of application are fairly reliable from year to year. However, techniques used in combining this information with information on application of expenditures in other sectors (Industry, the Federal Government, and the Universities) lack precision. For this reason caution should be exercised when interpreting these figures.

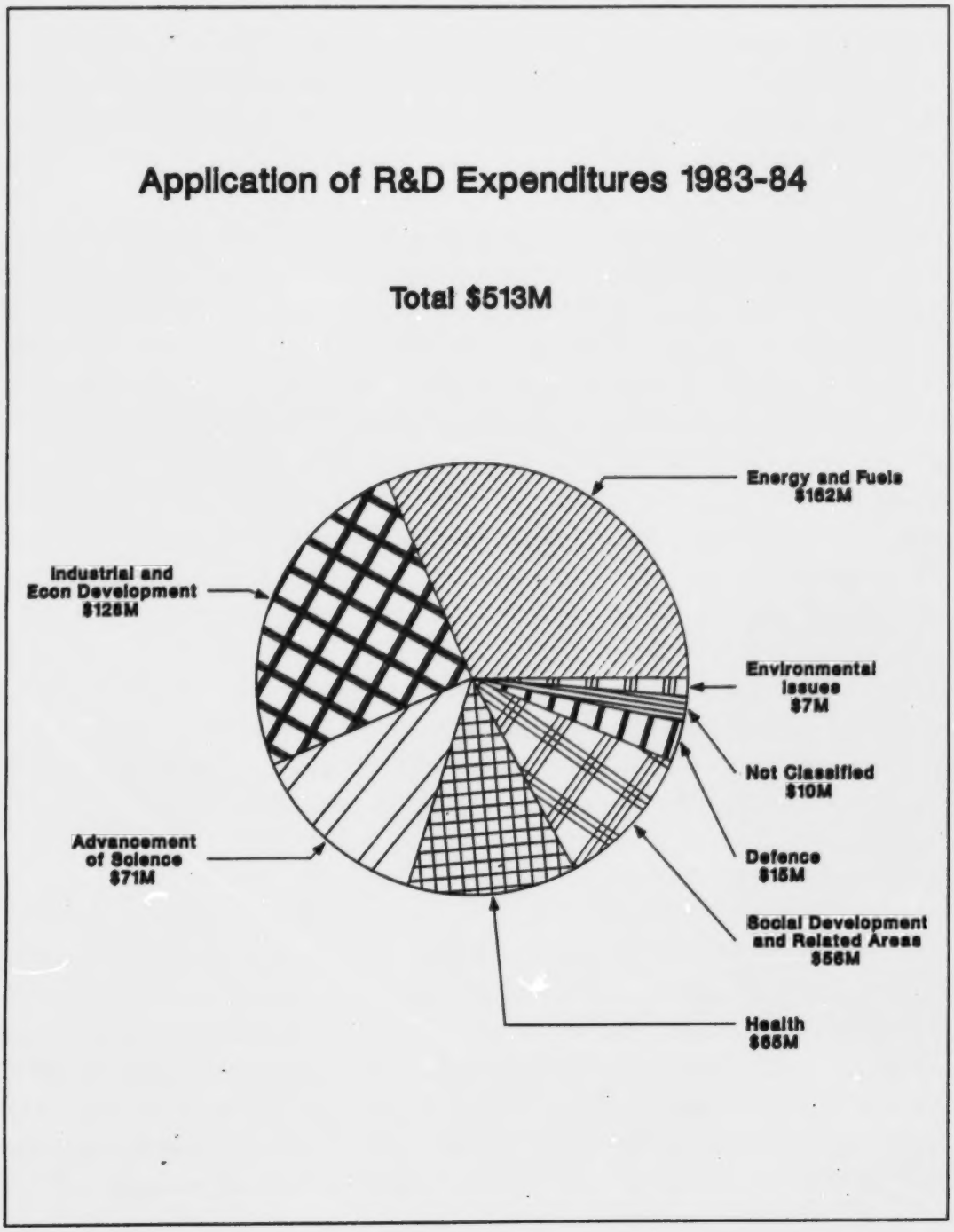
The primary performers of research and development are identified for each application area; however, no attempt has been made to categorize expenditures by funding source. Although sectors may have a strong focus in the performance of research and development (such as Industry's role in energy and fuels research), it should be remembered that funding is often received from several agencies. Because the Government of Alberta can be considered primarily a funder rather than a performer of research, its support role in many areas of application may be overlooked. In 1983-84, the Provincial Government was the source of 25 percent of all research and development expenditures in the Province. (Refer to Table 10 for a summary of total science expenditures of the Government of Alberta by area of application.)

Research and development expenditures have been broken into eight areas of application: Advancement of Science, Defence, Energy and Fuels, Environmental Issues, Health, Industrial and Economic Development, Social Development and Related Areas, and Transportation and Communications (Table 5).

5.1 Advancement of Science

It is estimated that approximately $71 million was spent on research and development activities related to the general advancement of science. This represented roughly 14 percent of all research and development expenditures in Alberta. With the exception of approximately $1 million of research performed by the Alberta Research Council, this figure largely reflects the activities of Alberta's Universities. In 1983-84, the University sector accounted for 97 percent of research activity related to the advancement of science (Table 5).

FIGURE 2


Application of R&D Expenditures 1983-84
Total $513M
Energy and Fuels $162M
Industrial and Econ Development $128M
Environmental Issues $7M
Not Classified $10M
Advancement of Science $71M
Defence $15M
Social Development and Related Areas $56M
Health $65M

The classification of research and development activities under this heading, in particular, involves problems of definition. This area involves research done for the general advancement of science and refers to basic rather than applied research. With the exception of the activities of a few faculties (such as Agriculture and Forestry, or Medicine, where area of application is reasonably clear), it is often difficult to classify the research activities of the universities. In recognition of the major role played by the universities in augmenting existing knowledge in all fields, much of their research activity was identified as serving the advancement of science.

5.2 Defence

Approximately $15 million was spent on activities related to defence, 3 percent of total research and development expenditures. Only the Federal Government reported expenditures in this application area.

5.3 Energy and Fuels

Approximately $162 million was spent on research and development activities in the area of energy and fuels in Alberta in 1983-84, representing 32 percent of all research and development expenditures in Alberta. The major performer of research and development activities in energy and fuels was Industry, accounting for 78 percent of expenditures in this area of application. The Provincial Government performed 8 percent, the Federal Government 6 percent, and the Alberta Research Council 7 percent (Table 5).

Energy and fuels includes the sub-fields of fossil fuels, hydro-electric energy, and nuclear energy. It appears that most of the expenditures in this area were related to fossil fuels.

5.4 Environmental Issues

An estimated $7 million was spent on research and development activities related to environmental issues. The Alberta Research Council and Alberta Government Departments were the primary performers, each accounting for approximately 50 percent of expenditures in this area (Table 5).

TABLE 5

APPLICATION OF RESEARCH AND DEVELOPMENT EXPENDITURES IN ALBERTA 1982-83 AND 1983-84

Area of Application	$ Millions (%)			
	1982-83(r)		1983-84	
Advancement of Science	69	(13)	71	(14)
Defence	11	(2)	15	(3)
Energy and Fuels	229	(41)	162	(32)
Environmental Issues	8	(1)	7	(1)
Health	53	(10)	65	(13)
Industrial and Economic Development:				
Agriculture	39	(7)	42	(8)
Other	82	(15)	86	(17)
Subtotal	122	(22)	128	(25)
Social Development and Related Areas	50	(9)	56	(11)
Transportation and Communications[1]	..	(..)	..	(..)
Not Classified[2]	11	(2)	10	(2)
Total	554	(100)	513	(100)

Notes: 1. Disaggregated data for industrial research and development in this category are not available from Statistics Canada. Industrial communications research in the Province is reported in the broader category of industrial and economic development.

2. In order to comply with the secrecy section of the Statistics Act, Industry may not list expenditures for certain industry groupings. For this reason expenditures of approximately $10 million per year could not be grouped by application area.

Source: Alberta Advanced Education, Planning Secretariat, estimates, July, 1985.

The area of environmental issues includes research activities intended to preserve or restore environmental quality, including work on pollution, but excluding related medical research.

5.5 Health

It is estimated that approximately $65 million was spent on health-related research and development activities in Alberta in 1983-84. This represented roughly 13 percent of all research and development expenditures in Alberta. Universities accounted for 71 percent of health related research and development and hospitals and health organizations 27 percent (Table 5).

The area of health involves activities related to the maintenance and improvement of the physical well-being of the population. Included are research activities in medicine, dentistry, pharmacy, nursing and rehabilitation medicine.

5.6 Industrial and Economic Development

It is estimated that approximately $128 million was spent on research and development activities in the area of industrial and economic development, representing roughly 25 percent of all research and development expenditures in Alberta in 1983-84. The private sector accounted for 45 percent of research and development in this application area, with expenditures of $28 million in manufacturing and $30 million in the service industries. The Federal Government performed the second largest share of research in this area (25 percent) in its research establishments throughout the Province. The Alberta Research Council accounted for 14 percent, the University sector 8 percent, and the Provincial Government Departments 6 percent (Table 5).

Industrial and economic development includes research activities related to agriculture, fisheries, forestry, manufacturing and minerals. In 1983-84, $42 million was directed towards research and development related to agriculture. The Federal Government was the primary performer in this area with approximately $24 million expended on agricultural research and development, while the Provincial Government, including the Alberta Research Council, expended an additional $10 million.

5.7 Social Development and Related Areas

It is estimated that approximately $56 million was spent on research and development activities in the area of social development, 11 percent of all research and development in Alberta. Universities accounted for essentially all research expenditures in this area (Table 5).

This area of application includes the sub-fields of culture, sport, recreation, education, human resources, and urban and regional studies.

6. PERSONNEL[1]

Only recently have consistent figures on the personnel component of research and development activities become available. However, data gathering remains hindered by significant technical and conceptual problems, making accurate assessments difficult.

For comparative purposes, the unit of 'person-year' is used to indicate a full-time equivalent staff position engaged directly in research and development. This allows an individual's time to be apportioned to different activity categories where that person is engaged in a variety of tasks, only some related to research and development.

Individuals engaged in research and development are classified either as 'professional and scientific personnel' or as 'technical and other support personnel'. (See Appendix B for definitions.)

6.1 Total Employment in Research and Development

The equivalent of 1 516 full-time persons were employed in a scientific or professional capacity engaged in research and development activities in the Province, not including the equivalent of 1 700 persons engaged in research in Alberta's Universities. The equivalent of an additional 1 878 persons, excluding those at Alberta Universities, were engaged on a full-time basis in a technical or other support capacity in an occupation related to research and development (Table 6).

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[1] Figures in this section indicate full-time equivalents or 'person-years'. Because each individual may be engaged in a variety of tasks apart from those directly related to research and development, the actual number of people who were employed in an occupation related to research and development would be several times greater than the figures quoted here.

TABLE 6

PERSONNEL ENGAGED IN INTRAMURAL RESEARCH AND DEVELOPMENT IN ALBERTA AND CANADA 1983-84 (PERSON-YEARS)

Sector and Field Of Employment	Scientific And Professional		Technical and Other Support		Total	
	Alberta	Canada	Alberta	Canada	Alberta	Canada
Provincial Government						
Natural Sciences	159	1 060	189	1 650	348	2 710
Social Sciences	16	170	5	140	21	310
Total	175	1 230	194	1 790	369	3 020
Provincial Research Organization(s)	157	406	187	555	344	961
Federal Government						
Natural Sciences	304	..	722	..	1 025	..
Social Sciences	--	..	--	..	--	..
Total	304	5 208	722	11 298	1 025	16 506
Industry	880	17 550	775	17 845	1 655	35 400

Sources: Statistics Canada, Federal Scientific Establishments, 1983-84; Statistics Canada, "The Provincial Research Organizations 1983", Science Statistics, Vol. 8, #11; Statistics Canada, Scientific Activities of the Government of Alberta 1983-84 Survey Results; Statistics Canada, Science, Technology and Capital Stock Division, estimates, July, 1985.

6.2 Provincial Government

The Alberta Government employed the equivalent of 175 scientific and professional persons during 1983-84, 159 of whom were engaged in natural science research. In addition, 157 scientific and professional persons were employed by the Alberta Research Council. The Provincial Government also employed the equivalent of 194 technical and other support persons, while the Alberta Research Council employed approximately 187 persons (Table 6).

The Alberta Government spent approximately $154 000 per professional researcher from its intramural research and development funds, up from $131 000 in 1982-83 (Table 7).

6.3 Federal Government

In the 15 federal research establishments located in Alberta, the Federal Government employed 304 scientific and professional persons or 6 percent of those employed in federal research establishments across Canada. Essentially all of these persons were engaged in natural science research and development. An additional 722 persons were employed in technical or support capacities (Table 6).

In 1983-84, the Federal Government spent $184 000 per professional research person in its Alberta establishments. Nationally, the Federal Government spent $235 000 on each of its professional research staff across Canada (Table 7).

6.4 Industry

Industry in Alberta employed 880 full-time equivalent scientific and professional personnel during 1983-84, about 5 percent of the total across Canada. An additional 775 persons were employed in technical or support capacities (Table 6).

In 1983-84, Alberta Industry spent $222 000 per professional research person, considerably greater than the Canadian average for Industry of $143 000 (Table 7).

TABLE 7

INTRAMURAL RESEARCH AND DEVELOPMENT
EXPENDITURES PER SCIENTIFIC AND PROFESSIONAL PERSON
ALBERTA AND CANADA
1983-84

	Provincial Government	Provincial Research Organizations	Federal Government	Industry
Alberta:				
Intramural R&D Expenditure ($ Millions)	27	33	56	195
Scientific and Professional Personnel (Person - Years)	175	157	304	880
Expenditure/Professional Person ($ Thousands)	154	210	184	222
Canada:				
Intramural R&D Expenditure ($ Millions)	160	59	1 224	2 518
Scientific and Professional Personnel (Person - Years)	1 230	406	5 208	17 550
Expenditure/Professional Person ($ Thousands)	130	145	235	143

Sources: Statistics Canada, Federal Scientific Establishments, 1983-84; Statistics Canada, Scientific Activities of the Government of Alberta 1983-84 Survey Results; Statistics Canada, Science, Technology and Capital Stock Division, estimates, July, 1985.

6.5 Universities

In theory, each of the 4 600 academic staff members in Alberta's Universities is a scientific or professional person directly engaged in research activities. However, the instructional and community service obligations of faculty members restrict the amount of time which may be committed to research activities. The full-time equivalent figure for staff engaged solely in research activities is estimated to be approximately 1 700 person-years for all Alberta Universities.

SECTION II
SCIENTIFIC ACTIVITIES OF THE GOVERNMENT OF ALBERTA: STATISTICS 1983-84

1. INTRODUCTION

This section summarizes the major findings of the report, Scientific Activities of the Government of Alberta, 1983-84 Survey Results (Appendix A). This section also provides comparative data on the 1983-84 expenditures of the Provincial Governments of Ontario, British Columbia and Saskatchewan.

Scientific activities are those activities which involve the generation, dissemination and initial application of new scientific knowledge and technology. Included are both research and development activities and related scientific activities. Related scientific activities are activities ancillary to research and development, which do not include the acquisition of new knowledge. They do include such activities as scientific data collection, feasibility studies, operations and policy studies, and educational support. Only the Federal Government and selected provincial governments collect expenditure data on related scientific activities.

2. TRENDS

Between 1977-78 and 1983-84, expenditures by the Government of Alberta for scientific activity increased 191 percent. The Saskatchewan Government increased expenditures 137 percent over the same period, the British Columbia Government 91 percent, and the Ontario Government 71 percent (see Figure 3).

The substantial increase in science expenditures by the Alberta Government over this seven year period is attributable to increased support by a number of departments. In 1983-84, the Department of Hospitals and Medical Care expended $22 million for scientific activity, an increase of 594 percent over its 1977-78 expenditure; the Department of Energy and Natural Resources expended $29 million, a 450 percent increase; and Alberta Agriculture expended $20 million, an increase of 421 percent (Appendix A, Table 2).

Research and development have accounted for the majority of the Alberta Government's science expenditures over the past seven years. Figure 4 provides an interprovincial comparison of research and development expenditures and reveals that the Governments of Ontario and Alberta have

FIGURE 3

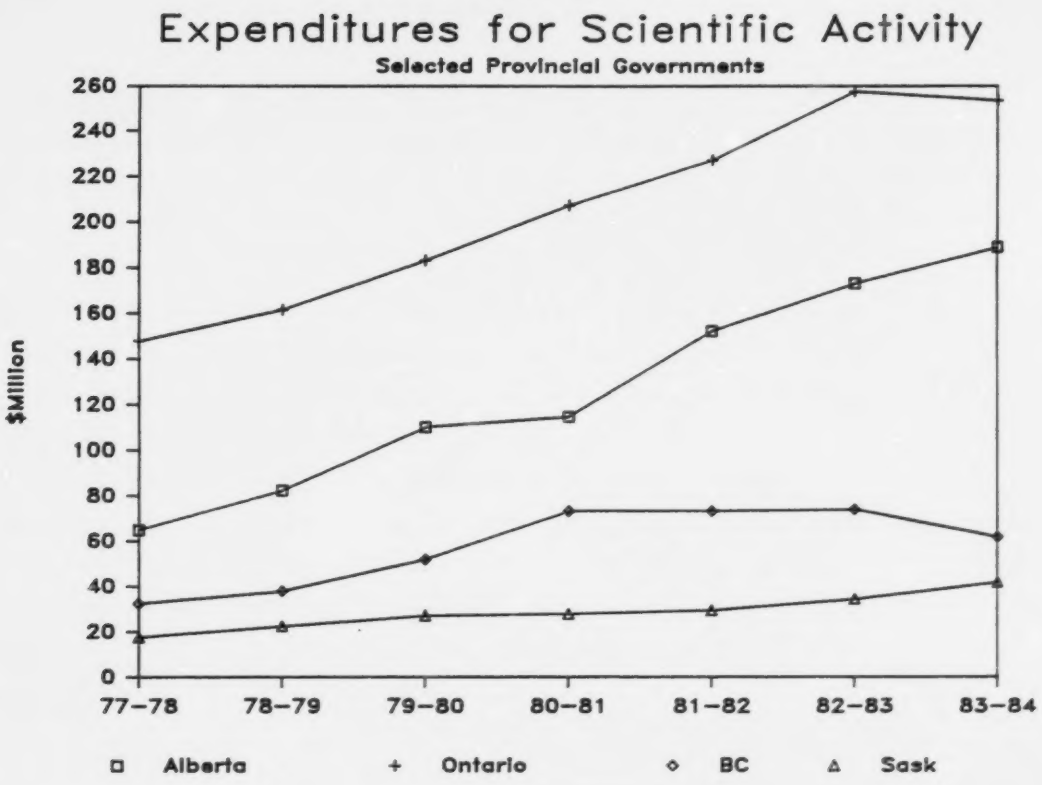
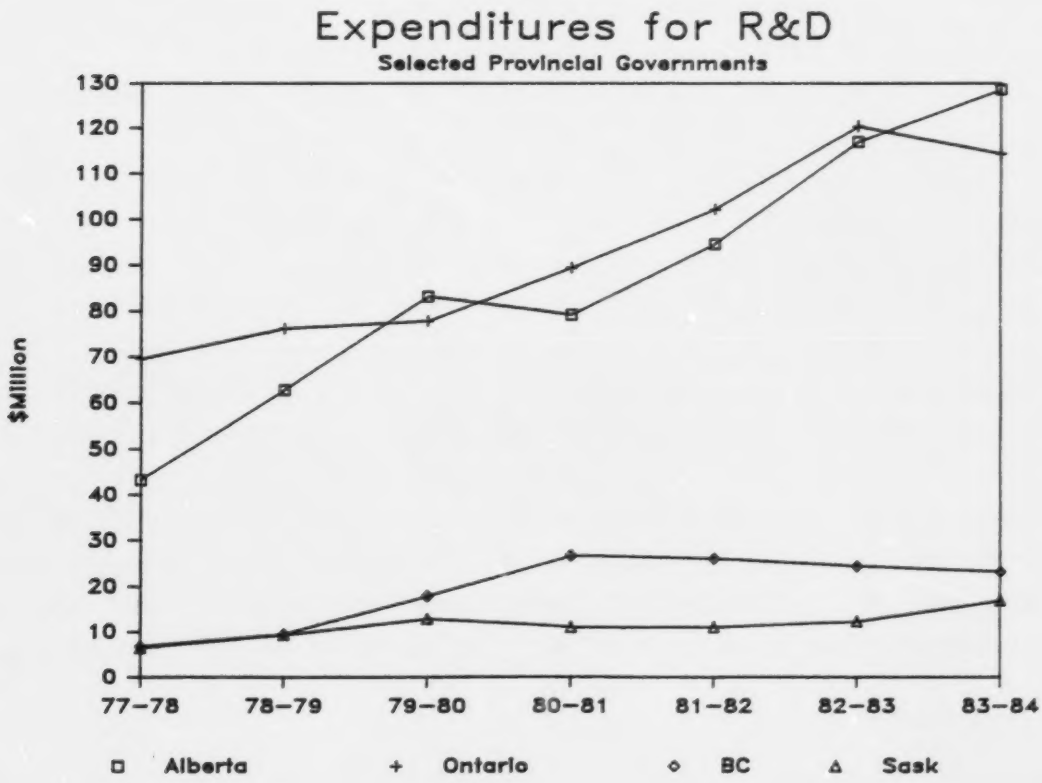


FIGURE 4



consistently led the other provinces surveyed in their support of research and development. By 1983-84 the Alberta Government was expending more for research and development than any other provincial government surveyed.

3. CHARACTERISTICS OF EXPENDITURES

A detailed description of the Alberta Government's expenditures on scientific activities for the year 1983-84 can be found in Appendix A. The following discussion highlights some of the important characteristics of these expenditures and draws comparisons with other provincial governments (Table 8).

Table 8 indicates that the Alberta Government's science expenditures show a somewhat different distribution from expenditures by other governments surveyed. Comparatively more funds are directed toward activities in the natural sciences, with the majority of expenditures supporting research and development. In 1983-84, 84 percent ($159 million of the Alberta Government's science expenditure) supported natural science activities, and of this, 79 percent ($126 million) was devoted to research and development.

This relatively high proportion of research and development in the natural sciences is maintained primarily by three departments or agencies. The Alberta Oil Sands Technology Research Authority accounted for approximately 35 percent ($41 million) of current expenditures for natural science research and development in 1983-84. Expenditures by the Department of Hospitals and Medical Care and the Executive Council's payments to the Alberta Research Council each accounted for an additional 17 percent ($20 million) (Appendix A, Table 25).

TABLE 8

EXPENDITURES ON SCIENTIFIC ACTIVITIES OF SELECTED PROVINCIAL GOVERNMENTS 1983-84

Type of Scientific Activities	Governments $ Millions (%)							
	Alberta		Ontario		Saskatchewan		British Columbia	
Natural Sciences								
Research and Development	126	(79)	91	(58)	16	(53)	23	(47)
Related Scientific Activities	33	(21)	67	(42)	14	(47)	26	(53)
Total Scientific Activities	159	(84)	158	(62)	31	(73)	48	(78)
Social Sciences								
Research and Development	2	(8)	23	(24)	1	(8)	1	(4)
Related Scientific Activities	28	(92)	72	(76)	11	(92)	13	(96)
Total Scientific Activities	30	(16)	96	(38)	12	(27)	13	(22)
Total								
Research and Development	129	(68)	114	(45)	17	(40)	23	(38)
Related Scientific Activities	61	(32)	139	(55)	25	(60)	38	(62)
Total Scientific Activities	189	(100)	254	(100)	42	(100)	62	(100)

Sources: Statistics Canada, annual surveys of scientific activities of participating provinces, 1983-84.

TABLE 9

EXPENDITURES ON SCIENTIFIC ACTIVITIES OF SELECTED PROVINCIAL GOVERNMENTS BY PERFORMER 1983-84

Performer	Governments $ Millions (%)							
	Alberta		Ontario		Saskatchewan		British Columbia	
Intramural	71	(37)	149	(59)	25	(58)	42	(67)
Provincial Research Organization	35	(19)	4	(2)	4	(10)	2	(3)
Hospitals and Health Organizations	17	(9)	8	(3)	--	(--)	--	(--)
Industry	43	(23)	35	(14)	6	(13)	10	(16)
University	15	(8)	45	(18)	6	(15)	6	(9)
Others	9	(5)	11	(5)	1	(3)	3	(5)
Total	189	(100)	254	(100)	42	(100)	62	(100)

Sources: Statistics Canada, annual surveys of scientific activities of participating provinces, 1983-84.

4. PERFORMERS

Compared with other provincial governments, the Alberta Government performs a relatively small proportion (37 percent) of the scientific activities it funds. Conversely, it expends a greater proportion (19 percent) in support of its provincial research organization: in 1983-84, the Alberta Research Council received $35 million in Provincial Government grants and contracts. Industry was the primary external performer, receiving $44 million (23 percent of the Alberta Government's science expenditure) in 1983-84 (Table 9).

The Alberta Oil Sands Technology Research Authority was the primary contributor to the industrial sector in 1983-84. Together with the Department of Agriculture, AOSTRA was also a major contributor to the university sector. Science expenditures in hospitals and health organizations were accounted for almost exclusively by the Department of Hospitals and Medical Care (Appendix A, Table 8).

While the Alberta Government conducts most of its own related scientific activities, only one-fifth of the research and development it funds is performed in-house (Appendix A, Table 7). Alberta Agriculture, Alberta Environment, the Environmental Centre, and the Department of Energy and Natural Resources were major performers of research and development in 1983-84 (Appendix A, Table 9).

5. APPLICATION

Compared with other provincial governments, the Alberta Government supports a greater share of scientific activities in the area of energy and fuels ($53 million or 28 percent of 1983-84 science expenditures). In 1983-84, equal emphasis was placed on activities related to industrial and economic development ($51 million or 27 percent of science expenditures). Nearly half (46 percent) of the support for industrial and economic development was directed toward activities related to agriculture (Table 10; Appendix A, Table 11).

TABLE 10

EXPENDITURES ON SCIENTIFIC ACTIVITIES
OF SELECTED PROVINCIAL GOVERNMENTS BY
APPLICATION
1983-84

Application	Governments $ Millions (%)							
	Alberta		Ontario		Saskatchewan		British Columbia	
Advancement of Science	9	(5)	14	(6)	1	(1)	1	(2)
Energy and Fuels	53	(28)	25	(10)	5	(13)	6	(9)
Environmental Issues	21	(11)	33	(13)	2	(4)	7	(11)
Health	29	(15)	37	(15)	10	(23)	5	(9)
Industrial and Economic Development	51	(27)	84	(33)	16	(39)	30	(49)
Social Development and Related Areas	22	(12)	52	(21)	6	(15)	11	(18)
Transportation and Communications	4	(2)	8	(3)	2	(4)	1	(2)
Total	189	(100)	254	(100)	42	(100)	62	(100)

Source: Statistics Canada, annual surveys of scientific activities of articipating provinces, 1983-84.

SECTION III
OVERVIEW OF RESEARCH AND SCIENCE IN ALBERTA

1. INTRODUCTION[1]

Research and development involves significant transfers of resources between units, organizations and sectors, especially between governments and other performers. The statistical sections of this report have portrayed the exchange of funds at the sectoral level. However, since the data are restricted to aggregated figures, it is difficult to present a complete picture of individual organizations.

The last section of the report, therefore, provides an overview of specific activities of various research units and organizations in the Province. **It is not an exhaustive listing of research funding and performing bodies in Alberta, but should be a representative survey of ongoing research activity.** Hopefully, this additional information will afford the reader a clearer understanding of the intricate network of research support that has evolved in the Province over the past few years.

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[1] Assistance with portions of Section III has been provided by the Office of Science and Technology of the Alberta Research Council, and by Alberta Economic Development.

2. GOVERNMENT OF ALBERTA

There are two aspects to the involvement of the Alberta Government in research and science. The first is the provision of programs in support of research in other performing sectors (extramural activity). The second is the ongoing activity of its departments and agencies whose mandates include research (intramural activity).

2.1 Extramural Support

Through various programs and agencies, the Alberta Government provides research support to universities, private industry, or to qualified individuals. Research assistance is available through:

Alberta Oil Sands Technology and Research Authority (AOSTRA). Established in 1975, AOSTRA is funded through the Alberta Heritage Savings Trust Fund and provides financial support to private firms and research institutions. Objectives are to develop economically viable and environmentally acceptable petroleum technology in areas related to oil sands, heavy oil and enhanced recovery of conventional oil. Research projects consist primarily of field projects with industry that are handled on a shared cost or cost recovery basis.

Alberta/Canada Energy Resources Research Fund (A/CERRF). As a result of the 1974 oil pricing agreement between the Federal Government and the producing provinces, the Federal Government committed $96 million to Alberta in support of energy-related research. Administered by Alberta Energy and Natural Resources, the fund supports research in the areas of: coal; conventional energy resources; energy conservation and renewable energy; and related capital projects.

Alberta Heritage Foundation for Medical Research (AHFMR). The AHFMR was created in 1979 to establish and support a balanced long-term program of medical research based in Alberta. Using the interest revenue generated from a $300 million endowment from the Alberta Heritage Savings Trust Fund, the Foundation supports researchers in the basic medical and clinical sciences, as well as in a broad spectrum of medical related disciplines.

Farming for the Future. An agricultural research program financed through the Alberta Heritage Savings Trust Fund, Farming for the Future was established to support the advancement of agricultural technology by initiating or augmenting research efforts by private industry, universities and government agencies.

Alberta Foundation for Nursing Research. The Foundation was established in 1982 to administer funds over five years to help nurses undertake research for the purpose of improving nursing practice.

Applied Cancer Research Fund. Established in 1977, this program will run until March, 1987 to provide funds for facilities, equipment, and operating expenses associated with applied research at specialized cancer referral centres.

Occupational Health and Safety Heritage Grant Program. This program was established in 1981 to support research and education designed to prevent accidents and ill health resulting from employment, and to promote the health of Alberta workers through improved working conditions.

2.2 Intramural Activities

In addition to its support of research activity in other performing sectors, the Alberta Government conducts research in its own labs and research facilities:

The Alberta Research Council (ARC). Located in Edmonton, with offices in Calgary, Devon, Red Deer, Nisku and Lethbridge, the ARC is Canada's oldest and largest provincial research organization. Six major research programs have been developed in the areas of: natural resources; oil sands; coal; industrial and engineering research; advanced technologies; and the applied sciences (including hydrocarbon upgrading, biotechnology and computing).

Alberta Agriculture. In-house research facilities of the Department of Agriculture include:

Food Processing Development Centre. This new facility in Leduc is available to food processors who use Alberta products and want to develop new processes or products or to improve existing ones.

Alberta Horticultural Research Centre. Located in Brooks, this centre conducts research for southern Alberta and participates in research for other parts of the Province in all aspects of crop production.

Regional Crops Laboratories. These laboratories, located at Brooks and Olds, study weeds, plant diseases and insect pests. The Olds lab is also involved in Alberta's seed potato improvement program. Both work closely with the Alberta Environmental Centre in Vegreville.

O.S. Longman Building. Laboratories at this Edmonton facility are involved in soil and feed testing, food analyses and product development. Work also centres around plant diseases, insect and animal pests, veterinary pathology and other veterinary medicine needs.

Other facilities and programs. Alberta Agriculture carries out research in Lethbridge in the area of irrigation systems, water use efficiency and other aspects of irrigation management, and is involved in weather modification research in cooperation with the Alberta Research Council. The department operates the Field Unit at Lacombe and veterinary laboratories at Airdrie, Edmonton, Fairview and Lethbridge.

Alberta Environment. The Research Management Division of Alberta Environment is responsible for administering research pertinent to departmental needs on environmental matters, including the identification and implementation of long-term environmental research programs. Over the past few years the

department has been involved in projects addressing a diverse range of environmental issues, including the study of acid forming emissions, reclamation research, waste management, and factors affecting human-biophysical environmental relationships.

Alberta Environmental Centre. Situated in Vegreville, the Centre is responsible for studying environmental problems identified by Provincial Government departments and agencies. It is Canada's first interdepartmental, interdisciplinary environmental research and service agency, focusing on applied research and development and the provision of analytical and laboratory services.

Eight research program areas have been established: analytical, diagnostic, extension and technical services; pest management; water/wastewater; environmental toxicology; living natural resources; waste management; and land resources management.

Energy and Natural Resources. Five units of Alberta Energy and Natural Resources report responsibilities in the area of research and science.

> Public Lands. This division conducts field investigations and inventories in order to examine such areas as soil characteristics, physical features and natural flora. The division also provides the public with technical support in the area of range management.
>
> Fish and Wildlife. This division conducts research into ecological and physiological variables affecting Alberta's fish and wildlife populations. The division has also been involved in the development of various methodologies of collecting, analyzing, or mapping data in order to describe the fish and wildlife resources of the Province.
>
> Resource Evaluation and Planning. The branch conducts technical surveys for evaluation of environmental parameters, including soils, vegetation, forest productivity, ecological relationships and climate.

Alberta Forest Service (AFS). The AFS conducts in-house research in the area of forest land management and provides research support to the Alberta forest products industry through its Forest Products and Forest Industrial Development Research Program. Alberta also has one of the finest forest genetics programs in North America, a joint effort of the AFS, industry and Alberta universities.

Scientific and Engineering Services. This division is responsible for overseeing a large volume of research and development, funded primarily through A/CERRF (see Section 2.1). Projects relate to furthering the development and use of energy resources, with emphasis on coal, renewables and energy conservation. Alberta's coal research capability has been greatly enhanced by the construction of a new research facility, built under the auspices of A/CERRF:

> Coal Research Centre, Devon. This new facility accommodates the research operation of the Alberta Research Council's Coal Program, the federal Coal Research Laboratory, and a private organization, the Coal Mining Research Centre. Thus, three major centres of Western Canadian coal research are housed under one roof, facilitating interaction and coordination of effort.

3. THE FEDERAL GOVERNMENT

Over 60 federal departments and agencies either perform scientific activity or have the budgetary allocation to fund such activity. Following are descriptions of selected federal programs and facilities pertinent to Alberta.

3.1 Extramural Support

Several agencies of the Federal Government offer programs in support of scientific activity in the university and industrial sectors:

Natural Sciences and Engineering Research Council of Canada (NSERC). This federal granting agency is a principal funder of university research in the natural sciences and engineering. Support is offered in the form of research grants, manpower awards, development grants and research infrastructure support.

Social Sciences and Humanities Research Council of Canada (SSHRC). Supporting research in fields as diverse as archaeology, transportation and social history, SSHRC offers universities funding for research support, training and communication.

Medical Research Council of Canada (MRC). The MRC provides grants to help defray the costs of basic, applied, experimental, or clinical research; provides salary support to a limited number of investigators and research trainees in Canadian universities; and sponsors programs to help develop research in fields where major contributions may be expected.

National Research Council Canada

> Industrial Research Assistance Program (IRAP). Administered locally by Alberta Research Council, this program is designed to enhance the commercial capabilities of companies by providing support to researchers engaged in industrial projects of high technical merit with prospects of high return.

Program for Industry/Laboratory Projects (PILP). Companies with sufficient technical and business capability to commercialize approved research project results are eligible for PILP support. The program involves the provision of access to science-based government laboratories and departments, and the technical assistance of their experts.

Department of Regional Industrial Expansion

Industrial and Regional Development Program (IRDP). This program provides support to projects at various stages of innovation and development.

Defence Industry Productivity Program (DIPP). DIPP is designed to enhance the technological competence of the defence industry in its export activities by providing assistance to industrial firms for selected projects.

3.2 Intramural Activities

The Federal Government's in-house research facilities in the Province include:

Agricultural Research Station, Lethbridge. The offices, laboratories and library of the Research Station form the major part of the complex known as the Agriculture Centre. The Centre also houses offices of Alberta Agriculture, representing a coordinated effort to serve agricultural research needs in one location. The station employs scientists working in six disciplinary areas: soil science, plant science, crop entomology, plant pathology, animal science, and animal parasitology.

Institute of Sedimentary and Petroleum Geology (ISPG). Adjacent to the University of Calgary, the ISPG serves government, industry and the scientific community in the provision of geological information. The Institute studies the sedimentary basins of western and northern Canada, focusing on bedrock geology, paleontology, and the assessment of coal, oil and gas resources.

Northern Forest Research Centre. This centre, located in Edmonton, is responsible for fulfilling the federal role in forestry research, development and technology transfer in Alberta, Saskatchewan, Manitoba and the Northwest Territories. Research is organized under three programs: environmental forestry; forest resources research (such as forest improvement and management); and forest protection.

Defence Research Establishment - Suffield (DRES). Located in Ralston, Alberta, DRES conducts basic and applied research on medical and chemical aspects of chemical defence, microbiology, chemical and biological defence training, military engineering applications and the disposal of hazardous and toxic materials.

Coal Research Laboratory (CRL). At the forefront of coal research and technology conducted by Energy, Mines and Resources Canada is the Coal Research Laboratory based in the Devon Coal Research Centre. The CRL has served the Western Canadian coal industry for more than thirty years. Activity centres around four research areas: preparation of coal for the marketplace; effective means of water treatment; coal carbonization; and oil - water emulsion techniques.

4. THE PRIVATE SECTOR

Industrial research aimed at developing Alberta's natural resources has spawned an extensive support base of related industries, including firms involved in petrochemical, seismic, telecommunications, computer processing and medical technology. The following section highlights some of these related industries, many of which have evolved technological applications in a broad range of research areas. The list is not intended to include all research performing units in the Province, but should be a representative survey of ongoing research activity in these emerging technologies.[1]

Global Thermoelectric Power Systems Ltd. is one of the companies in the Province exploring alternate power sources. Global researchers have developed a remote power system which burns gaseous fuels, converting them directly to electric power. Global is one of only two manufacturers in the world producing thermoelectric generators.

Canadian General Electric established its R&D Energy and Resources operation in Edmonton in 1981 as part of its strategic plan to diversify into the resource sector. One of the projects now under way involves modifying GE's hydraulic remote manipulator (Man-Mate) for use in the energy industry.

INTERA Technologies Ltd. has adapted a Synthetic Aperture Radar system (STAR 1) for generating images mounted on small aircraft for commercial use. The system has found wide application in advising Arctic drilling and navigation projects of ice movement in northern waters.

Nortech Surveys (Canada) Ltd., also involved in navigational high technology, supervises extensive applied research and development programs with

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[1] Major petroleum recovery industries with research units in Alberta are not included in this summary. Although they account for the majority of industrial research and development expenditures in the Province, their activities are well documented elsewhere. See for example, Statistics Canada, Directory of Industrial Research and Development Facilities in Canada, 1985, Minister of Supply and Services Canada, 1985.

applications for resource-based industries, including energy and forestry. In addition, the company is currently developing a computer-based navigational system linked to satellite rather than ground signals, permitting the use of less expensive fixed-wing aircraft instead of helicopters.

Geotechnical Resources Ltd. develops and applies new technology to a range of sophisticated lab and testing services for the exploration and development sectors of the petroleum industry in Western Canada, the Arctic and abroad. Geotech has diversified into areas related to its rock core, gas and fluids analysis services.

Sherritt Gordon Mines Ltd. operates a large nickel and cobalt refinery at Fort Saskatchewan. All of the processes in use at the Sherritt plant have been developed by its research organization over the past 30 years.

Vandore Enterprises Ltd. is currently in the final phase of research and development prior to construction of a $12 million to $15 million vanadium extraction plant. Vanadium production could emerge as a key secondary oil sands industry in the next several years.

Dow Chemical Canada manufactures a variety of industrial chemical products, and operates a chemical research facility in association with its plant in Fort Saskatchewan.

Raylo Chemicals Ltd. and Terochem Laboratories Ltd. are producers of high technology specialty chemicals. Recently, the companies have entered into the aerospace plastics business and have specialty high polymers in the experimental stage. The companies are also looking into ways of manufacturing DNA derivatives which can be used in genetic engineering.

NOVA, an Alberta Corporation is active in gas transportation and marketing, petroleum, petrochemicals, manufacturing and research. Two major projects were emphasized in 1984. Objectives of the first project were to provide the gas control computer system with superior control capability, and to make additional capacity available. The second project involved a computerized measurement system to incorporate innovative design functions developed by NOVA.

Digitech Ltd. is involved in advanced digital processing of seismic data. One of its current projects is the transfer of Digitech software into interactive graphic work stations allowing greater data access to exploration geologists in the field. Prototypes of this data-based digital processing system are already in use and represent one of many innovations revolutionizing the seismic industry in Alberta.

Sefel Geophysical Ltd. is undertaking extensive research and development through the Sefel Research Corporation. In 1984, Sefel installed super-array computer hardware at its research centre that will be central to a new development program aimed at three dimensional navigation and seismic systems.

Teknica Resources Development Ltd., also serving the seismic industry, is an established firm that has pioneered the use of computer imaging techniques for geophysical interpretation.

Bell Northern Research Ltd. has extensive laboratory facilities in Alberta. The company places a major emphasis on fibre optic research and related transmission product development. Research extends to areas including high-capacity fibre optics transmission for long-haul voice telecommunication, fibre optics transmission between metropolitan offices and fibre optic installation equipment.

Novatel Communications Ltd. developed the first cellular phone system in North America, AURORA, which went into commercial operation in 1983. The AURORA telecommunications system links microprocessor capabilities with a state-of-the-art computer based control, representing one of the most sophisticated mobile phone systems in the world.

Idacom Electronics Ltd. designs and manufactures telecommunications test equipment and develops the software to run it. The company is alone in providing a reference and test tool for a seven layer communications protocol.

EDO Corporation designs and manufactures advanced electronics and specialized equipment for military, aviation and industrial markets. The Fibre Science Division was awarded a contract by Beech Aircraft Corporation for the

manufacture of prototype composite structures for Starship I, a new advanced corporate aircraft.

Caulfield Engineering developed the world's first stereo sidescan sonar system, the Acoustic Core, to measure ocean depth. It takes readings on either side of a vessel's path within a swath of 50 meters and has been used for construction of artificial drilling islands in the Arctic.

Harding Instruments Company Ltd. One of Harding's newest products is the two-line key telephone system designed for use in small businesses or residences.

Niart International Inc. designs, manufactures, installs and maintains traffic control products including signal heads, controllers/cabinet assemblies and computerized traffic control systems. This new company is jointly owned by Niart Inc., Vencap Equities Alberta Ltd., and Canadian General Electric of Toronto. The company's research activities focus on research and development of solid state electronics and the creation of major software systems.

D.B. Robinson and Associates operates a state-of-the-art experimental research lab doing contract work in fluid properties and phase behaviour, and in specialized computer software development for hauling oil and gas.

Robertson Photogrammetric Inc. employs photographic techniques coupled with electronic scanning and computer programs to do jobs ranging from detecting minute changes on the wing surfaces of F-18 and F-20 fighters to mineral survey work.

Myrias Research Corporation, a young Alberta company, has designed and is building what may prove to be the fastest and most powerful supercomputer in the world. The Myrias 4000, a unit comprised of 4 096 Motorola 68000 microprocessors, will simultaneously perform a record number of functions.

Synerlogic Inc. is presently promoting its "Act 1" system, a software program that enables professional computer programmers to build an architectural model or blueprint of a planned project.

Keyword Office Technologies Ltd. The Calgary based company recently announced new software modules for its disk-to-disk document interchange system, the KEYWORD 7000. Keyword currently supplies 200 software products that make information exchange possible between different brands of word processors and personal computers.

Willowglen Systems Ltd. is a competitor in the international marketplace with its exclusive Supervisory Control and Data Acquisition (SCADA) system. "SCADA" is the only remote computerized control system of its kind in Canada.

Computalog Gearhart Ltd. provides the oil industry with specialized services such as open-hole logging and measurement while drilling directional wells. The open-hole logging procedure uses sophisticated electronic instruments to measure various characteristics of geological formations such as depth, cleanliness, porosity and fluid content.

Chembiomed Ltd., a company owned by the University of Alberta, has developed the technology to chemically produce blood purifiers and manufacture blood typing reagents using cloned cells from mice.

Bio Logicals Inc. is currently involved in a joint venture genetic engineering project with the Alberta Research Council aimed at the development of pharmaceuticals and specialty chemicals.

Summa Biomedical Canada Ltd. Summa scientists are working in a unique collaborative venture with the University of Alberta to develop blood tests designed for routine use with groups susceptible to certain cancers.

5. THE UNIVERSITY SECTOR

Alberta's three major universities train skilled researchers in all fields of art and science, and work closely with industry and government on basic and applied problems in research and development.

The following description focuses on the activities of faculties who report receipts of research funds from outside agencies: it should be borne in mind, however, that sponsored research constitutes only a portion of on campus research and scholarship. Numerous studies requiring only the institution's existing resources and the investigator's scholarly reflection are conducted in virtually every university department.

University of Alberta. The University of Alberta in Edmonton is the Province's oldest and largest research performing institution. The University gears its industrial laboratory research towards Alberta's current economic base in agriculture, oil and gas; to resource areas of future significance in forestry and coal; to new product development in fields such as pharmaceuticals and engineering design technology; and to the application of new technology in existing industrial systems through microelectronics and other areas on the leading edge of international developments.

Recent research initiatives at the University of Alberta include:

Alberta Microelectronics Centre. Partially supported by a $13 million allocation from the Alberta Government, the Centre will expand to house silicon microchip design facilities in Calgary and fabrication facilities at the University of Alberta.

Alberta Telecommunications Research Centre. Jointly operated by Bell Northern Research and the University of Alberta, the Centre will promote research in fibre optics, optoelectronics and related areas.

Alberta Agricultural Research Institute. A joint enterprise of the University of Alberta and Alberta Agriculture, the Institute will conduct basic and applied research on agricultural problems.

Canadian Pacific (C.P.) Research Program. C.P., together with McGill University, and the Universities of Manitoba, Saskatchewan and Alberta, has created a consortium to conduct a five year program of biotechnological research into problems of Western Canadian agriculture.

Alberta Laser Institute. Governed by a Board of Directors with strong industrial representation, the Institute will specialize in laser research related to robotics, manufacturing, and microchip processing.

Centre for Frontier Engineering Research. Established as a joint venture with several private firms, the Devonian Foundation and the University, the Centre deals with specialized research and development in cold regions products.

University of Calgary. This relatively young university is earning an impressive reputation for attracting outside research support. The Faculties of Medicine, Engineering and Science account for most of the grants and contracts, and encompass nine major medical research groups in areas ranging from genetic engineering to cell regulation and behavioral sciences. There are leading programs in survey, chemical and petroleum, civil and electrical engineering. Basic research in chemistry and biotechnology bears application to agriculture and forestry, and university researchers have been involved in major environmental projects. Petroleum related research includes an institute of sulphur chemistry, investigations of oil sands bitumen, basic studies of geological phenomena related to enhanced oil recovery, and a large scale geophysical (seismic) project. Other emerging research strengths at the University are related

to intensive computer software development, a VLSI design facility, mathematical interpolation methods for representation of digital data, and satellite imaging techniques.

Particular research strengths at the University of Calgary include:

Alberta Microelectronics Centre. Expansion of the Centre from Edmonton, to include silicon microchip design facilities at the University of Calgary.

Supercomputer Facilities. Acquisition of the CYBER 205 supercomputer, one of only four supercomputers in North American universities. Wide ranging applications in complex problem solving will increase research potential in industry, government, and the university research community.

JADE. The JADE project is directed at developing programs for a network of heterogeneous computers and terminals for future business, professional, and educational information systems.

Institute for Transportation Studies. This established research institute is an interdisciplinary organization, carrying out projects related to urban transportation, air transportation, and tourism.

Alberta Sulphur Research Institute. The Institute acts as a research and training bridge between industry and academia, investigating problems in the production, handling, transportation, and use of elemental sulphur.

Canadian Centre for Learning Systems (CCLS). This non-profit organization involves Calgary's five educational institutions, the Federal Government, and several private firms. Objectives of the CCLS are to develop and evaluate the use of learning systems at all levels of education.

University of Lethbridge. Providing post-secondary education to Albertans at the undergraduate level, the University of Lethbridge maintains a significant research budget. Research at the University includes: individual projects on the environmental effects of oil sands plants; development processes in poplar and maize; animal parasites in water systems; aspects of neuropsychology; and perceptual problems in infants.